APPENDIX C
HUMAN HEALTH EFFECTS FROM FACILITY ACCIDENTS

C.1 INTRODUCTION

Accident analyses were performed to estimate the impacts on workers and the public from reasonably foreseeable accidents associated with the Modern Pit Facility (MPF). The analyses were performed in accordance with *National Environmental Policy Act* (NEPA) guidelines, including the process followed for the selection of accidents, definition of accident scenarios, and estimation of potential impacts. The sections that follow describe the methodology and assumptions, accident selection process, selected accident scenarios, and consequences and risks of the accidents evaluated.

C.2 OVERVIEW OF METHODOLOGY AND BASIC ASSUMPTIONS

An accident is a sequence of one or more unplanned events with potential unmitigated outcomes that endanger the health and safety of workers and the public. An accident can involve a combined release of energy and hazardous materials (radiological or chemical) that might cause prompt or latent health effects. The sequence usually begins with an initiating event, such as a human error, equipment failure, or earthquake, followed by a succession of other events that could be dependent or independent of the initial event, which dictate the accident's progression and the extent of materials released. Initiating events fall into three categories:

- *Internal initiators* normally originate in and around the facility, but are always a result of facility operations. Examples include equipment or structural failures and human errors.
- *External initiators* are independent of facility operations and normally originate from outside the facility. Some external initiators affect the ability of the facility to maintain its confinement of hazardous materials because of potential structural damage. Examples include aircraft crashes, vehicle crashes, nearby explosions, and toxic chemical releases at nearby facilities that affect worker performance.
- *Natural phenomena initiators* are natural occurrences that are independent of facility operations and occurrences at nearby facilities or operations. Examples include earthquakes, high winds, floods, lightning, and snow. Although natural phenomena initiators are independent of external facilities, their occurrence can involve those facilities and compound the progression of the accident.

If an accident were to occur involving the release of radioactive or chemical materials, workers, members of the public, and the environment would be at risk. Workers in the facility where the accident occurs would be particularly vulnerable to the effects of the accident because of their location. The offsite public would also be at risk of exposure to the extent that meteorological conditions exist for the atmospheric dispersion of released hazardous materials. Using approved computer models, the dispersion of released hazardous materials and their effects are predicted. However, prediction of latent potential health effects becomes increasingly difficult to quantify for facility workers as the distance between the accident location and the worker decreases. This is because the individual worker exposure cannot be precisely defined with respect to the presence of shielding and other protective features. The worker also may be injured or killed by physical effects of the accident itself.

C.3 ACCIDENT ANALYSIS METHODOLOGY AND DATA SOURCES

The analysis of accidents followed a systematic process beginning with the identification of potentially hazardous conditions associated with the MPF, followed by the selection and definition of a representative set of accident scenarios, development of data requirements (source term, release duration, and estimate of frequency of accident condition), and the calculation of postulated accident consequences for the environment, members of the public, and site workers.

The accident analysis includes conservative assumptions to bound potential consequences and risks to workers and the public as well as to compensate for any uncertainties in the data and methods as required for NEPA purposes. In particular, no credit is taken for facility design features that would reduce accident damage to the material at risk (damage ratio = 1.0) and to confinement barriers that prevent materials from reaching the environment (leak path factor = 1.0). Realistically, the MPF would be designed and operated to protect the material at risk and confinement barriers that would significantly reduce the potential consequences and risks of accidents to workers and the public compared to the results presented in this EIS.

Data Sources

Major sources of data and information used for the development of accident scenarios included: (1) the best available documentation on postulated accidents at similar facilities, including recently completed NEPA documents for similar facilities; and (2) meetings and discussions with expert site representatives. Initial data regarding the MPF and its processing steps were obtained from the document *Modern Pit Facility Request for Approval of Mission Need—Critical Decision–0* (NNSA 2002).

Source Documents

Documentation on postulated accidents at similar facilities was the initial source of accident scenarios. Documents such as safety analysis reports and NEPA documents were reviewed for applicable accident scenarios. The review sought to identify a spectrum of accidents, initiated internally by operations or initiated externally. This spectrum of accidents included low-consequence/high-probability events (evaluation basis accidents) and high-consequence/low-probability events (beyond evaluation basis accidents). The initial set of documents that were reviewed included the following:

- *Topical Report – Supporting Documentation for the Accident Impacts Presented in the Modern Pit Facility Environmental Impact Statement* (Tetra Tech 2003)
- *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996c)
- *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory* (DOE 1999a)
- *Final Supplement Analysis for Pit Manufacturing Facilities at Los Alamos National Laboratory, Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (DOE 1999f)

- *TA-55 Final Safety Analysis Report* (LANL 1995a)
- *Topical Report – Supporting Documentation for the Accident Impacts Presented in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (Maltese et al., 1996)
- *Modern Pit Facility Pre-Conceptual Design Radiological Hazards Evaluation* (WSRC 2002d)

Based on these documents, a candidate set of facility hazards and accident scenarios were defined that was judged to provide an adequate representation of the potential accidents that might occur at the MPF. This initial set of candidate accidents was screened to arrive at a final set of accident scenarios for analysis and documentation in this Environmental Impact Statement (EIS).

Following the review of applicable documents, the accident scenarios and source terms were further refined and confirmed through meetings and discussions with knowledgeable personnel familiar with similar facilities and processes.

C.4 ACCIDENT SCENARIO SELECTION PROCESS

This section describes the development of accident scenarios that were used to estimate the impacts of MPF operations. As discussed in Section C.2, accident scenarios were developed using all known applicable sources of information including safety analysis reports, previous NEPA documents and related backup information, and discussions with experts familiar with potential accidents for MPF operations.

Development of Accident Scenarios

A preliminary hazard evaluation for a MPF was performed that identified potential hazards associated with nuclear weapons pit manufacturing (WSRC 2002d). These identified hazards formed the basis for the selection and definition of a set of accident scenarios analyzed in the MPF EIS. The steps in the process were:

1) Assemble and review all available information and technical resources applicable to the MPF buildings, equipment, processes, and operations
2) Identify potential hazardous and accident conditions
3) Define a preliminary set of candidate accident scenarios
4) Select a final set of accidents, develop scenarios, and derive applicable data for analysis in the MPF EIS

Four general guidelines, listed below, were followed in the selection of the MPF accident scenarios.

1) Hazardous and accident conditions should include the largest source terms at risk and conditions for worker and public impacts.

2) The accident scenarios selected should cover a spectrum of accident situations ranging from high-probability/low-consequence events to low-probability/high-consequence events.
3) For each probability range the accident with bounding consequences should be selected as representative for the range.
4) The accident scenarios should reflect differences resulting from site-specific initiators, meteorology, and characteristics (e.g., distance from site boundary and other adjacent facilities). The accidents do not take credit for any of the safety systems required for the facility.

Hazards Evaluation

Based on available documentation and technical resources, potential hazard, and accidents associated with MPF site conditions, facilities, processes, and operations were identified. These fall in to three categories:

1) Accidents initiated internal to the MPF (e.g. MPF processes, equipment, operations and workers)
2) Accidents initiated external to the MPF
3) Accidents initiated by natural phenomena events (e.g. earthquake, flooding, high winds)

Internally initiated accidents in Category 1 will generally be the same for all sites where new construction is planned. Externally initiated accidents and natural phenomena events in Categories 2 and 3 are site specific.

Internally Initiated Hazards

Detailed design information was not yet available for use in the MPF EIS. However, for purposes of EIS hazards evaluation, the following process steps were assumed.

- Shipment/Storage
- Disassembly
- Enriched Uranium Processing
- Dissolution
- Solvent Extraction
- Precipitation
- Metal Reduction
- Electrorefining
- Accountability and Button Storage
- Foundry
- Machining

- Assembly, Post Assembly, and Inspection
- Laboratory
- Balance of Plant

MPF-related facility radiological and chemical accidents for three production cases (125 pits per year [ppy], 250 ppy, and 450 ppy) are described in Tables C.4–1 through C.4–4. These tables also identify the estimated maximum material at risk (MAR) and source term and accident frequency. Section C.5 provides additional data on release fractions such as damage ratio, leak path factor, and estimated respirable release fraction (RRF) for each postulated accident. The RRF is the mathematical product of the airborne release fraction (ARF) and the respirable fraction (RF) calculated by the equation RRF = ARF × RF (Tetra Tech 2003).

Natural Phenomena Accidents

Natural phenomena events have the potential for causing damage to the facility and the release of radioactive and other hazardous materials. Natural phenomena events that were considered include earthquake, tornado, high winds, flooding, wild fires, snow, and ice. Tables C.4–1 through C.4–4 identify natural phenomena accidents that were selected for further analysis based on their potential for causing the release of radioactive materials that would bound other natural phenomena events. These tables and Section C.5 also provide data on accident scenarios pertaining to MAR, source term, frequency, and release fractions.

Postulated Accidents

The accident scenarios shown in Tables C.4–1 through C.4–4 cover the types of hazardous situations appropriate for the MPF EIS. The list includes fires, spills, criticality and explosions events, site-specific externally initiated events, and natural phenomena events. For radiological accidents, the material at risk is plutonium and the predominant form of exposure is through inhalation. For some plutonium processes, such as pit disassembly and conversion, tritium, whose predominant form of exposure is through ingestion, may also be present. However, the pits associated with the MPF Facility do not present a tritium hazard because they do not contain residual amounts of tritium. For radiological accidents, the material at risk is plutonium and the predominant form of exposure is through inhalation. The list also includes the potential release of toxic chemicals used in MPF processes.

The results of the accident analysis indicate potential consequences that exceed the DOE exposure guidelines of 25 rem for a member of the public at the nearest site boundary. The analyses in these cases for NEPA purposes are based on unmitigated releases of radioactive material to select a site for the MPF. Following the ROD and selection of a site, additional NEPA action would be taken that would identify specific mitigating features that would be incorporated in the MPF design to ensure compliance with DOE exposure guidelines. These could include procedural and equipment safety features, HEPA filtration systems, and other design features that would protect radioactive materials from accident conditions and contain any material that might be released. Upon completion of MPF NEPA actions, DOE would prepare safety analysis documentation such as a safety analysis report to further ensure that DOE exposure guidelines would not be exceeded. The results of the safety analysis report are reflected in facility and equipment design and defines an operating envelope and procedures to ensure public and worker safety. Once specific mitigation measures are incorporated into the MPF design and operating procedures, the potential consequences will not exceed the DOE exposure guidelines of 25 rem for a member of the public at the nearest site boundary for any of the site alternatives.

The accident source terms shown in Tables C.4–1 through C.4–4 indicate the quantity of radioactive and chemical material released to the environment with a potential for harm to the public and onsite workers. The radiological source terms are calculated by the equation:

Source Term = MAR × ARF × RF × DR × LPF, where:

MAR—the amount and form of radioactive material at risk of being released to the environment under accident conditions.

ARF—the airborne release fraction reflecting the fraction of damaged MAR that becomes airborne as a result of the accident.

RF—the respirable fraction reflecting the fraction of airborne radioactive material that is small enough to be inhaled by a human.

DR—the damage ratio reflecting the fraction of MAR that is damaged in the accident and available for release to the environment.

LPF—the leak path factor reflecting the fraction of respirable radioactive material that has a pathway out of the facility for dispersal in the environment.

Table C.4–1. Postulated MPF-Related Facility Radiological Accidents for the 125 ppy Case

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Natural Phenomena Events				
1. Beyond Evaluation Basis Earthquake with Fire	A seismic event is postulated causing failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas of the facility. Combustible materials in the area are ignited and the fire propagates to multiple areas and storage vaults containing the largest quantity of plutonium metal.	16,988 kg plutonium-239 equivalent: 99.65% metal 0.21 % powder, 0.14 % solution	4.23 kg metal 0.0021 kg oxide 0.048 kg solution	1.0×10^{-6} to 1.0×10^{-5} /yr
Externally Initiated Events				
1. Air Transportation Accident	Addressed in Official Use Only Document			
Internal Process Events				
1. Fire in a Single Building	A fire is postulated to start within a glovebox, processing room or storage vault. The fire propagates to multiple areas involving the largest quantities of plutonium metal.	7685 kg plutonium metal	1.92 kg plutonium	1.0×10^{-6} to 1.0×10^{-4} /yr
2. Explosion in a Feed Casting Furnace	A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over-pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. Negligible impacts from the shock/blast are postulated for the solid plutonium metal in the glovebox.	4.5 kg molten plutonium metal	2.25 kg molten plutonium metal	1.0×10^{-4} to 1.0×10^{-2} /yr

Table C.4–1. Postulated MPF-Related Facility Radiological Accidents for the 125 ppy Case *(continued)*

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Internal Process Events *(continued)*				
3. Nuclear Criticality	An inadvertent criticality is postulated based on several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios.	See Table 3–1[a]	See Table 3–1[a]	1.0×10^{-2} /yr
4. Fire-induced Release in the CRT Storage Room	A fire is postulated to occur in the cargo restraint transporter storage room.	600 kg plutonium metal	0.15 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr
5. Radioactive Material Spill	A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace.	4.5 kg molten plutonium metal	0.045 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr

[a] Tetra Tech 2003.
Source: Tetra Tech 2003.

Table C.4–2. Postulated MPF-Related Facility Radiological Accidents for the 250 ppy Case

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Natural Phenomena Events				
1. Beyond Evaluation Basis Earthquake with Fire	A seismic event is postulated causing failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas of the facility. Combustible materials in the area are ignited and the fire propagates to multiple areas and to storage vaults containing the largest quantity of plutonium metal.	17,319 kg plutonium-239 equivalent: 99.44% metal 0.28 % powder 0.28 % solution	4.31 kg metal 0.00296 kg oxide 0.096 kg solution	1.0×10^{-6} to 1.0×10^{-5} /yr
Externally Initiated Events				
1. Air Transportation Accident	Addressed in Official Use Only Document			
Internal Process Events				
1. Fire in a Single Building	A fire is postulated to start within a glovebox, processing room, or storage vault. The fire propagates to multiple areas involving the largest quantities of plutonium metal.	7943 kg plutonium metal	1.99 kg plutonium	1.0×10^{-6} to 1.0×10^{-4} /yr
2. Explosion in a Feed Casting Furnace	A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. Negligible impacts from the shock/blast are postulated for the solid plutonium metal in the glovebox.	4.5 kg molten plutonium metal	2.25 kg molten plutonium metal	1.0×10^{-4} to 1.0×10^{-2} /yr

Table C.4–2. Postulated MPF-Related Facility Radiological Accidents for the 250 ppy Case *(continued)*

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Internal Process Events *(continued)*				
3. Nuclear Criticality	An inadvertent criticality is postulated based on several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios.	See Table 3-1[a]	See Table 3–1[a]	1.0×10^{-2} /yr
4. Fire-induced Release in the CRT Storage Room	A fire is postulated to occur in the cargo restraint transporter storage room.	600 kg plutonium metal	0.15 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr
5. Radioactive Material Spill	A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace.	4.5 kg molten plutonium metal	0.045 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr

[a] Tetra Tech 2003.
Source: Tetra Tech 2003.

Table C.4–3. Postulated MPF-Related Facility Radiological Accidents for the 450 ppy Case

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Natural Phenomena Events				
1. Beyond Evaluation Basis Earthquake with Fire	A seismic event is postulated causing failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas of the facility. Combustible materials in the area are ignited and the fire propagates to multiple areas and to storage vaults containing the largest quantity of plutonium metal.	33,447 kg plutonium-239 equivalent 99.51% metal 0.24 % powder 0.25 % solution	8.32 kg metal 0.0048 kg oxide 0.17 kg solution	1.0×10^{-6} to 1.0×10^{-5} /yr
Externally Initiated Events				
1. Air Transportation Accident	Addressed in Official Use Only Document			
Internal Process Events				
1. Fire in a Single Building	A fire is postulated to start within a glovebox, processing room, or storage vault. The fire propagates to multiple areas involving the largest quantities of plutonium metal.	15420 kg plutonium metal	3.86 kg plutonium	1.0×10^{-6} to 1.0×10^{-4} /yr
2. Explosion in a Feed Casting Furnace	A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over- pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. Negligible impacts from the shock/blast are postulated for the solid plutonium metal in the glovebox.	4.5 kg molten plutonium metal	2.25 kg molten plutonium metal	1.0×10^{-4} to 1.0×10^{-2} /yr

Table C.4–3. Postulated MPF-Related Facility Radiological Accidents for the 450 ppy Case *(continued)*

Accident	Accident Description	Material at Risk	Source Term	Event Frequency
Internal Process Events *(continued)*				
3. Nuclear Criticality	An inadvertent criticality is postulated based on several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios.	See Table 3–1[a]	See Table 3-1[a]	1.0×10^{-2} /yr
4. Fire-induced Release in the CRT Storage Room	A fire is postulated to occur in the cargo restraint transporter storage room.	1200 kg plutonium metal	0.3 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr
5. Radioactive Material Spill	A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace.	4.5 kg molten plutonium metal	0.045 kg plutonium	1.0×10^{-4} to 1.0×10^{-2} /yr

[a] Tetra Tech 2003.
Source: Tetra Tech 2003.

Table C.4–4. Postulated MPF-Related Facility Chemical Accidents for All Production Cases

Chemical Release Events				
1. Nitric Acid release from bulk storage	Nitric acid is inadvertently released from bulk storage due to natural phenomena, equipment failure, mechanical impact, or human error during storage, handling, or process operations.	125 ppy – 10,500 kg 250 ppy – 21,000 kg 450 ppy – 40,000 kg	125 ppy – 10,500 kg 250 ppy – 21,000 kg 450 ppy – 40,000 kg	1.0×10^{-5} to 1.0×10^{-4} /yr
2. Hydrofluoric Acid Release from Bulk Storage	Hydrofluoric acid is inadvertently released from bulk storage due to natural phenomena, equipment failure, mechanical impact, or human error during storage, handling, or process operations.	125 ppy – 550 kg 250 ppy – 1,100 kg 450 ppy – 2,000 kg	125 ppy – 550 kg 250 ppy – 1,100 kg 450 ppy – 2,000 kg	1.0×10^{-5} to 1.0×10^{-4} /yr
3. Formic Acid Release from Bulk Storage	Formic acid is inadvertently released from bulk storage due to natural phenomena, equipment failure, mechanical impact, or human error during storage, handling, or process operations.	125 ppy – 1,500 kg 250 ppy – 3,000 kg 450 ppy – 5,500 kg	125 ppy – 1,500 kg 250 ppy – 3,000 kg 450 ppy – 5,500 kg	1.0×10^{-5} to 1.0×10^{-4} /yr

Source: Tetra Tech 2003.

The accident source terms for chemical accidents are shown in Table C.4–4. The impacts of chemical accidents are measured in terms of ERPG-2 and ERPG-3 concentration limits established by the American Industrial Hygiene Association. ERPG-2 is defined as the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective actions. ERPG-3 is defined as the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

C.5 ACCIDENT SCENARIO DESCRIPTIONS AND SOURCE TERMS

The final set of accidents scenarios for the MPF Alternative are described in Section C.5.1 for three pit production cases (125, 250, and 450 ppy). They include potential radiological and chemical accidents that are initiated by internal MPF mechanisms, events external to MPF and natural phenomena. The selected accidents are based on conservative assumptions in order to obtain bounding impacts. A summary of accident data for the MPF Alternative is presented in Table C.5–1. Accident information pertaining to the No Action Alternative and the TA-55 Upgrade Alternative are provided in Sections C.5.2 and C.5.3, respectively.

Table C.5–1. Summary of Potential Facility Accidents for the MPF Alternative

Accident	Material at Risk[a]	Source Term[a]
Beyond Evaluation Basis Earthquake with Fire	<u>125 ppy</u> 16,929 kg plutonium metal 35 kg plutonium oxide 24 kg plutonium solution <u>250 ppy</u> 17,221.9 kg plutonium metal 49.1 kg plutonium oxide 48 kg plutonium solution <u>450 ppy</u> 33,282.5 kg plutonium metal 80.5 kg plutonium oxide 84 kg plutonium solution	<u>125 ppy</u> 4.23 kg plutonium metal 0.0021 kg plutonium oxide 0.048 kg plutonium solution <u>250 ppy</u> 4.31 kg plutonium metal 0.00295 kg plutonium oxide 0.096 kg plutonium solution <u>450 ppy</u> 8.32 kg plutonium metal 0.00483 kg plutonium oxide 0.168 kg plutonium solution
Fire in a Single Building	125 ppy – 7,685 kg plutonium metal 250 ppy – 7,943 kg plutonium metal 450 ppy – 15,420 kg plutonium metal	125 ppy – 1.92 kg plutonium metal 250 ppy – 1.99 kg plutonium metal 450 ppy – 3.86 kg plutonium metal
Explosion in a Feed Casting Furnace	125 ppy – 31.5 kg molten plutonium metal 250 ppy – 31.5 kg molten plutonium metal 450 ppy – 31.5 kg molten plutonium metal	125 ppy – 2.25 kg molten plutonium metal 250 ppy – 2.25 kg molten plutonium metal 450 ppy – 2.25 kg molten plutonium metal

Table C.5–1. Summary of Potential Facility Accidents for the MPF Alternative (*continued*)

Accident	Material at Risk[a]	Source Term[a]
Nuclear Criticality	See Table 3-1	5 x 10^{17} fissions
Fire-Induced Release in the CRT Storage Room	125 ppy – 600 kg plutonium metal 250 ppy – 600 kg plutonium metal 450 ppy – 1,200 kg plutonium metal	125 ppy – 0.15 kg molten plutonium metal 250 ppy – 0.15 kg molten plutonium metal 450 ppy – 0.30 kg molten plutonium metal
Radioactive Material Spill	125 ppy – 4.5 kg molten plutonium metal 250 ppy – 4.5 kg molten plutonium metal 450 ppy – 4.5 kg molten plutonium metal	125 ppy – 0.045 kg molten plutonium metal 250 ppy – 0.045 kg molten plutonium metal 450 ppy – 0.045 kg molten plutonium metal
Nitric Acid Release from Bulk Storage[b]	125 ppy – 10,500 kg 250 ppy – 21,000 kg 450 ppy – 40,000 kg	125 ppy – 10,500 kg 250 ppy – 21,000 kg 450 ppy – 40,000 kg
Hydrofluoric Acid Release from Bulk Storage[b]	125 ppy – 550 kg 250 ppy – 1,100 kg 450 ppy – 2,000 kg	125 ppy – 550 kg 250 ppy – 1,100 kg 450 ppy – 2,000 kg
Formic Acid Release from Bulk Storage[b]	125 ppy – 1,500 kg 250 ppy – 3,000 kg 450 ppy – 5,500 kg	125 ppy – 1,500 kg 250 ppy – 3,000 kg 450 ppy – 5,500 kg
Hydrochloric Acid[c]	125 ppy – 600 kg 250 ppy – 1,200 kg 450 ppy – 2,200 kg	125 ppy – 600 kg 250 ppy – 1,200 kg 450 ppy – 2,200 kg

[a] Plutonium-239 equivalent.
[b] Chemicals are used in the aqueous processing method.
[c] Chemical is used in the pyrochemical processing method.
Source: Tetra Tech 2003.

C.5.1 Modern Pit Facility Alternative

Postulated accident scenarios applicable to the MPF are described below. The accidents shown were analyzed and their consequences are presented in the Section C.7. The accidents shown are generally applicable to all sites although some reflect unique site-specific conditions that are not applicable to all sites.

C.5.1.1 Beyond Evaluation Basis Earthquake with Fire

The earthquake accident scenario postulates a seismic event and seismically induced failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas in the facility. Combustible materials in the area are ignited and the resulting fire propagates to multiple areas of the facility and including storage vaults in three buildings containing the largest quantity of plutonium metal. The plutonium-239 equivalent MAR for the 125 ppy production case includes 16,988 kilograms (kg) (37,452 pounds [lb]) metal, 35 kg (77 lb) oxide, and 24 kg (53 lb) solution. The plutonium-239 equivalent MAR for the 250 ppy production case includes 17,319 kg (38,182 lb) metal, 49.1 kg (108 lb) oxide, and 48 kg (106 lb) solution. The plutonium-239 equivalent MAR for the 450 ppy production case includes 33,447 kg (73,738 lb) of metal, 80.5 kg (177.5 lb) oxide, and 84 kg (185 lb) solution. The bounding seismic accident with fire conservatively assumes a damage ratio (DR) = 1.0 resulting in all of the MAR to be affected by the fire. The collapsed walls cause a loss of confinement resulting in an assumed leak path factor (LPF) = 1.0. The airborne respirable release fraction is estimated to be ARF*RF = 2.5×10^{-4} (metal), 6×10^{-5} (oxide), and 2×10^{-3} (solution). No credit is taken for the mitigating effects of safety systems, fire suppression efforts and equipment, plutonium cladding, the shipping containers or the final building state (building collapse and rubble bed). The resulting plutonium-239 equivalent source term for the 125 ppy case is 4.23 kg (9.3 lb) of metal, 0.0021 kg (0.0046 lb) of oxide, and 0.048 kg (0.11 lb) of solution. The resulting plutonium-239 equivalent source term for the 250 ppy case is 4.31 kg (9.5 lb) metal, 0.00295 kg (0.0065 lb) oxide, and 0.096 kg (0.212 lb) solution. The resulting plutonium-239 equivalent source term for the 450 ppy case is 8.32 kg (18.3 lb) metal, 0.00483 kg (0.11 lb) oxide, and 0.168 kg (0.37 lb) solution. The accident frequency is estimated to be in the range of 1×10^{-6} to 1×10^{-5} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-5} per year is assumed.

C.5.1.2 Air Transportation Accident

The air transportation accident is addressed in an Official Use Only document.

C.5.1.3 Ground Transportation Accident

The ground transportation accidents are addressed in Appendix D.

C.5.1.4 Fire in a Single Building

A fire is postulated to start within a glovebox, processing room, or storage vault. Possible causes of the fire include an electrical short, equipment failure, welding equipment, or human error. The fire propagates to multiple areas of the facility involving the largest quantities of plutonium metal. The material at risk is a maximum 7,685 kg (16,943 lb) of plutonium metal for the 125 ppy case; 7,943 kg (17,511 lb) plutonium metal for the 250 ppy case; and 15,420 kg (33,995 lb) plutonium for the 450 ppy case. The bounding fire accident conservatively assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. No credit is taken for safety systems, building confinement, or filtration resulting in an assumed LPF = 1.0. The airborne respirable release fraction is estimated to be ARF*RF = 2.5×10^{-4}. No credit is taken for the mitigating effects of fire suppression efforts and equipment, plutonium cladding or the shipping containers. The resulting source term is a ground level, thermal release of 1.92 kg (4.23 lb), 1.99 kg (4.39 lb), and 3.86 kg (8.5 lb) of plutonium-239 equivalent for the three production cases 125, 250, and 450 ppy, respectively. The accident frequency is estimated to be in the range of 1×10^{-6} to 1×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-4} per year is assumed.

C.5.1.5 Explosion in a Feed Casting Furnace

A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over-pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. The material at risk is the same for all three pit production cases. The furnace is assumed to contain 4.5 kg (9.9 lb) of plutonium in the form of molten metal. The airborne respirable release fraction was estimated to be ARF*RF = 0.5 for the 4.5 kg (9.9 lb) of plutonium. Negligible impacts from the shock/blast are postulated for 9 kg (19.8 lb) of solid plutonium metal in the glovebox. The bounding scenario assumes a DR = 1.0 and an LPF = 1.0. The resulting source for each of the three pit production cases is 2.25 kg (5.0 lb) plutonium-239 equivalent. The frequency of the accident is estimated to be in the range 1×10^{-4} to 1×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-2} was used.

C.5.1.6 Nuclear Criticality

An inadvertent criticality is postulated based on any one of several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios. Table 3–1 of Chapter 3 in Volume I of this EIS (Tetra Tech 2003) provides the radionuclide distribution for a 5×10^{17} fissions criticality involving weapons grade plutonium. The estimated frequency of a criticality is 1×10^{-2} per year.

C.5.1.7 Fire-Induced Release in the Cargo Restraint Transporter Storage Room

A fire is postulated to start in cargo restraint transporter storage room. The fire is confined to the room. The MAR in the room is 600 kg (1,322.8 lb) plutonium metal for the 125 and 250 ppy production cases and 1200 kg (2,645.6 lb) plutonium metal for the 450 ppy production case. The bounding scenario assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. No credit is taken for building confinement or filtration resulting in an assumed LPF = 1.0. The airborne respirable fraction is estimated to be ARF*RF = 2.5×10^{-4}. No credit is taken for the mitigating effects of fire suppression efforts and equipment, plutonium cladding or shipping containers. The resulting source term is a ground level, thermal release of 0.15 kg (0.33 lb), 0.15 kg (0.33 lb), and 0.3 kg (0.66 lb) of plutonium-239 equivalent for the three production cases 125, 250, and 450 ppy, respectively. The accident frequency is estimated to be in the range of 1×10^{-4} to 1×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-2} per year is assumed.

C.5.1.8 Radioactive Material Spill

A spill of radioactive material occurs in the metal reduction glovebox. A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace. The event does not impact any other material that may be in the glovebox. The spill is assumed to involve 4.5 kg (9.9 lb) molten plutonium metal for each of the three production cases. An airborne release from disturbed metal surfaces is assumed the release mechanism. The airborne respirable release fraction is estimated to be ARF*RF = 1×10^{-2}. A DR = 1.0 was conservatively assumed. For a bounding scenario, no credit is taken for safety systems, building confinement, or ventilation/filtration corresponding to LPF = 1.0. The resulting source term is a ground level release of 0.045 kg (9.9 lb) plutonium-239 equivalent for each of the three pit production cases. The accident frequency is estimated to be in the range of 1×10^{-4} to 1×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-2} per year is assumed.

C.5.1.9 Nitric Acid Release

An accidental release of nitric acid from bulk storage is postulated due to equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Nitric acid is corrosive and can cause severe burns to all parts of the body. Its vapors may burn the respiratory tract and may cause pulmonary edema, which could prove fatal. The nitric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of nitric acid that could be released is 10,500 kg (23,149 lb) for the 125 ppy production case, 21,000 kg (46,297 lb) for the 250 ppy production case, and 40,000 kg (88,185 lb) for the 450 ppy production case. The nitric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 6 and 78 parts per million (ppm), respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} is assumed.

C.5.1.10 Hydrofluoric Acid Release

An accidental release of hydrofluoric acid from bulk storage is postulated due to equipment failure, mechanical impact, or human error. Hydrofluoric acid is extremely toxic and may be fatal if inhaled or ingested. It is readily absorbed through the skin and skin contact may be fatal. It acts as a systemic poison, causes severe burns and is a possible mutagen. The hydrofluoric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of hydrofluoric acid that could be released is 550 kg (1,212.5 lb) for the 125 ppy production case, 1,100 kg (2,425 lb) for the 250 ppy production case, and 2,000 kg (4,409 lb) for the 450 ppy production case. The hydrofluoric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 20 and 50 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.1.11 Formic Acid Release

An accidental release of formic acid from bulk storage is postulated due to equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Formic acid is corrosive and will cause severe burns. It is harmful by inhalation, ingestion, and readily absorbed through skin. It is very destructive to mucous membranes and the upper respiratory tract, eyes, and skin. Inhalation may be fatal. The formic acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of formic acid that could be released is 1,500 kg (3,307 lb) for the 125 ppy production case, 3,000 kg (6,614 lb) for the 250 ppy production case, and 5,500 kg (12,125 lb) for the 450 ppy production case. The formic acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 10 and 30 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.1.12 Hydrochloric Acid Release

An accidental release of hydrochloric acid from bulk storage is postulated due to natural phenomena, equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Hydrochloric acid is corrosive and will cause severe burns. It is harmful by inhalation, ingestion, and readily absorbed through skin. Inhalation may be fatal. The hydrochloric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of hydrochloric acid that could be released is 1,497 kg (3,300 lb) for the 80 ppy production case. The hydrochloric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 10 and 30 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.2 No Action Alternative

Under the No Action Alternative, plutonium pit fabrication capabilities would be maintained at existing levels. Potential accident scenarios for the No Action Alternative are addressed in existing documentation included by reference (DOE 1999f, DOE 1996c, LANL 1995a).

C.5.3 TA-55 Upgrade Alternative

Under the TA-55 Upgrade Alternative, the Plutonium Facility, Building 4 (PF-4) at TA-55 would be upgraded to provide a capability to manufacture up to 80 ppy. The changes to PF-4 to achieve this capability are assumed to be equivalent to the operations, processes, and technology and safety systems planned for a MPF. As such, the potential hazards and accidents postulated for a MPF would be applicable to the upgraded PF-4 with appropriate adjustments for the reduced production capacity. Table C.5.3–1 summarizes the accident scenarios for the TA-55 Upgrade Alternative.

Table C.5.3–1. Summary of Potential Facility Accidents for the Upgrade Alternative

Accident	MAR[a]	Source Term[a]
Beyond Evaluation Basis Earthquake and Fire	11,160 kg plutonium metal 22.4 kg plutonium oxide 15.4 kg plutonium solution	2.7 kg plutonium metal 0.0014 kg plutonium oxide 0.03 kg plutonium solution
Fire in a Single Building	4,918 kg plutonium metal	1.23 kg plutonium-239 equivalent
Explosion in a Feed Casting Furnace	31.5 kg molten plutonium metal	2.52 kg plutonium-239 equivalent
Nuclear Criticality	See Table 3-1[b]	5×10^{17} fissions
Fire-Induced Release in the CRT Storage Room	384 kg plutonium metal	0.096 kg plutonium-239 equivalent
Radioactive Material Spill	4.5 kg molten plutonium metal	0.045 kg plutonium-239 equivalent
Nitric Acid Release from Bulk Storage	3,420 kg	3,420 kg
Hydrofluoric Acid Release from Bulk Storage	340 kg	340 kg
Hydrochloric Acid Release from Bulk Storage	1,497 kg	1,497 kg

[a] Plutonium-239 equivalent.
[b] Tetra Tech 2003.

C.5.3.1 Beyond Evaluation Basis Earthquake and Fire

The earthquake accident scenario postulates a seismic event and seismically induced failure of interior nonstructural walls. The collapsed walls cause a loss of confinement and a potential release of materials in multiple areas in the facility. Combustible materials in the area are ignited and the resulting fire propagates to multiple areas of the facility including storage vaults in three buildings containing the largest quantity of plutonium metal. The plutonium-239 equivalent material at risk for the 80 ppy production case is 11,160 kg (24,603 lb) metal, 22.4 kg (49.4 lb) oxide, and 15.4 kg (34 lb) solution. The bounding seismic accident with fire conservatively assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. The collapsed walls cause a loss of confinement resulting in an assumed LPF = 1.0. The airborne respirable release fraction is estimated to be ARF*RF = 2.5×10^{-4} (metal), 6.0×10^{-5} (oxide), and 2.0×10^{-3} (solution). No credit is taken for the mitigating effects of safety systems, fire suppression efforts, and equipment, plutonium cladding, or the shipping containers. The resulting plutonium-239 equivalent source term is 2.7 kg (6.0 lb) of metal, 0.0014 kg (0.0031 lb) of oxide, and 0.03 kg (0.066 lb) of solution. The accident frequency is estimated to be in the range of 1×10^{-6} to 1×10^{-5} per year. For the purpose of risk calculations, a conservative frequency of 1×10^{-5} per year is assumed.

C.5.3.2 Air Transportation Accident

The air transportation accident is addressed in an Official Use Only document.

C.5.3.3 Ground Transportation Accident

The ground transportation accidents are addressed in Appendix B.

C.5.3.4 Fire in a Single Building

A fire is postulated to start within a glovebox, processing room or storage vault. Possible causes of the fire include an electrical short, equipment failure, welding equipment, or human error. The fire propagates to multiple areas of the facility involving the largest quantities of plutonium metal. The MAR is a maximum 4,918 kg (10,842 lb) of plutonium metal for the 80 ppy case. The bounding fire accident conservatively assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. No credit is taken for safety systems, building confinement, or filtration resulting in an assumed LPF = 1.0. The airborne respirable release fraction is estimated to be ARF*RF = 2.5×10^{-4}. No credit is taken for the mitigating effects of fire suppression efforts and equipment, plutonium cladding or the shipping containers. The resulting source term is a ground-level, thermal release of 1.23 kg (2.7 lb) of plutonium-239 equivalent. The accident frequency is estimated to be in the range of 1.0×10^{-6} to 1×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.3.5 Explosion in a Feed Casting Furnace

A steam explosion/over-pressurization is postulated to occur in a feed casting furnace in the foundry. The steam explosion occurs due to a cooling water leak or an over-pressurization event. The explosion/over-pressurization impacts molten plutonium metal in seven furnaces. The furnace is assumed to contain 4.5 kg (9.9 lb) of plutonium in the form of molten metal. The airborne respirable release fraction was estimated to be ARF*RF = 0.5 for the 4.5 kg (9.9 lb) of plutonium. Negligible releases from the shock/blast are postulated for 9 kg (19.8 lb) of solid plutonium metal in the glovebox. The bounding scenario assumes a DR = 1.0 and an LPF = 1.0. The resulting source for each of the three pit production cases is 2.25 kg (5.0 lb) plutonium-239 equivalent. The frequency of the accident is estimated to be in the range 1.0×10^{-4} to 1.0×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-2} was used.

C.5.3.6 Nuclear Criticality

An inadvertent criticality is postulated based on any one of several potential events involving handling errors. Accumulation of fissile material in excess of criticality safety limits, addition of a moderator causing a critical configuration, or a seismic event causing collapse of storage vault racks are potential scenarios. Table 3-1 provides the radio nuclide distribution for a 5×10^{17} fissions criticality involving weapons grade plutonium. The estimated frequency of a criticality is 1.0×10^{-2} per year.

C.5.3.7 Fire-Induced Release in the Cargo Restraint Transporter Storage Room

A fire is postulated to start in cargo restraint transporter storage room. The fire is confined to the room. The MAR in the room is 384 kg (847 lb) plutonium metal for the 80 ppy production case. The bounding scenario assumes a DR = 1.0 resulting in all of the MAR to be affected by the fire. No credit is taken for building confinement or filtration resulting in an assumed LPF = 1.0. The airborne respirable fraction is estimated to be ARF*RF = 2.5×10^{-4}. No credit is taken for the mitigating effects of fire suppression efforts and equipment, plutonium cladding or shipping containers. The resulting source term is a ground-level, thermal release of 0.096 kg (0.21 lb) of plutonium metal. The accident frequency is estimated to be unlikely in the range of 1.0×10^{-4} to 1.0×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-2} per year is assumed.

C.5.3.8 Radioactive Material Spill

A spill of radioactive material occurs in the metal reduction glovebox. A loss of confinement and spill of molten plutonium into the metal reduction glovebox is postulated. The spill occurs due to a failure or rupture of the feed casting furnace. The event does not impact any other material that may be in the glovebox. The spill is assumed to involve 4.5 kg (9.9 lb) molten plutonium metal. An airborne release from disturbed metal surfaces is assumed the release mechanism. The airborne respirable release fraction is estimated to be ARF*RF = 1.0×10^{-2}. A DR =1.0 was conservatively assumed. For a bounding scenario, no credit is taken for building confinement or ventilation/filtration corresponding to LPF = 1.0. The resulting source term is a ground-level release of 0.045 kg (0.099 lb) plutonium-239 equivalent. The accident frequency is estimated to be unlikely in the range of 1.0×10^{-4} to 1.0×10^{-2} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-2} per year is assumed.

C.5.3.9 Nitric Acid Release

An accidental release of nitric acid from bulk storage is postulated due to natural phenomena, equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Nitric acid is corrosive and can cause severe burns to all parts of the body. Its vapors are corrosive to the respiratory tract and may cause pulmonary edema, which could prove fatal. The nitric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of nitric acid that could be released is 3,420 kg (7,540 lb) for the 80 ppy, production case. The nitric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 6 and 78 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.3.10 Hydrofluoric Acid Release

An accidental release of hydrofluoric acid from bulk storage is postulated due to natural phenomena, equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Hydrofluoric acid is extremely toxic and may be fatal if inhaled or ingested. It is readily absorbed through the skin and skin contact may be fatal. It acts as a systemic poison, causes severe burns, and is a possible mutagen. The hydrofluoric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of hydrofluoric acid that could be released is 340 kg (750 lb) for the 80 ppy, production case. The hydrofluoric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 20 and 80 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.5.3.11 Hydrochloric Acid Release

An accidental release of hydrochloric acid from bulk storage is postulated due to natural phenomena, equipment failure, mechanical impact, or human error. The accident scenario postulates a major leak, such as a pipe rupture, and the released chemical forming a pool about one inch in depth in the area around the point of release. Hydrochloric acid is corrosive and will cause severe burns. It is harmful by inhalation, ingestion, and readily absorbed through skin. It is very destructive to mucous membranes and the upper respiratory tract, eyes, and skin. Inhalation may be fatal. The hydrochloric acid is assumed to be stored in bulk quantity in an outdoor facility at MPF. The maximum amount of formic acid that could be released is 1,497 kg (3,300 lb) for 80 ppy production case. The hydrochloric acid is released by evaporation to the environment and is transported as an airborne plume with potential impacts in excess of ERPG-2 and ERPG-3 concentration limits to onsite workers and the offsite public. The ERPG-2 and ERPG-3 concentration limits for the chemical are 10 and 30 ppm, respectively. The estimated frequency of this accident is in the range of 1.0×10^{-5} to 1.0×10^{-4} per year. For the purpose of risk calculations, a conservative frequency of 1.0×10^{-4} per year is assumed.

C.6 CONSEQUENCE ANALYSIS METHODOLOGY

Radiological Releases

Consequences of accidental radiological releases were determined using the MACCS2 computer code (Chanin and Young 1998). MACCS2 is a DOE/Nuclear Regulatory Commission (NRC)-sponsored computer code that has been widely used in support of probabilistic risk assessments for the nuclear power industry and in support of safety and NEPA documentation for facilities throughout the DOE complex.

The MACCS2 code uses three distinct modules for consequence calculations. The ATMOS module performs the calculations pertaining to atmospheric transport, including dispersion, deposition, and decay. The EARLY module performs the exposure calculations corresponding to the period immediately following the release; this module also includes the capability to simulate evacuation from areas surrounding the release. The EARLY module exposure pathways include inhalation, cloud shine, and groundshine. The CHRONC module considers the time period following the early phase, i.e., after the plume has passed (usually 7 days). CHRONC exposure pathways include groundshine, resuspension inhalation, and ingestion of contaminated food and water; land use interdiction (e.g., decontamination, interdiction) can be simulated in this module. Other supporting input files include a meteorological data file and a site data file containing distributions of the population and agriculture surrounding the release site.

All of the code's capabilities were not used because of assumptions used in the MPF EIS analysis. It was assumed that there would be no evacuation or protection of the surrounding population following an accidental release of radionuclides. In addition, the food pathway was not included. The former assumption is not expected to significantly affect the calculated doses; the amount of warning preceding a release is likely to be small. The latter assumption is made to simplify the calculation process and yet not significantly affect the results. A conservative assumption, that the deposition velocity of all radioactive material was set to zero, was instead made.

The source terms were handled by the code by considering the MAR as the inventory. The release fraction of each scenario was then the product of the various factors (DR, ARF, RF, and LPF) that describe the material available to actually impact a receptor. The meteorological data consisted of sequential hourly wind speed, wind direction, stability class and precipitation for one year.

Each 4-hour period of the annual meteorological site specific data set for each site was randomly sampled, assuring a good representation of the entire meteorological data set. The results from each of these samples were then ranked and combined (according to their frequency of occurrence) and a distribution of results is presented by the code. This distribution includes statistics such as 95th percentile, 50th percentile, and mean dose. The latter is presented in the MPF EIS. The doses were converted into latent cancer fatalities (LCFs) using the International Commission on Radiological Protection (ICRP) factor of 5×10^{-4} LCF/person-rem for members of the general public. For workers, the ICRP factor of 4×10^{-4} LCF/person-rem was used.

Chemical Releases

Consequences of accidental chemical releases were determined using the ALOHA computer code (EPA 1999b). ALOHA is an EPA/National Oceanic and Atmospheric Administration (NOAA)-sponsored computer code that has been widely used in support of chemical accident responses and also in support of safety and NEPA documentation for DOE facilities.

The ALOHA code is a deterministic representation of atmospheric releases of toxic and hazardous chemicals. The code can predict the rate at which chemical vapors escape (e.g., from puddles or leaking tanks) into the atmosphere; a specified direct release rate is also an option. In the case of the MPF EIS, the chemical direct release rates were determined based on a 30-minute release as part of the scenario development.

Either of two dispersion algorithms are applied by the code, depending on whether the release is neutrally buoyant or heavier than air. The former is modeled similarly to radioactive releases in that the plume is assumed to advect with the wind velocity. The latter considers the initial slumping and spreading of the release because of its density. As a heavier-than-air release becomes more dilute, its behavior tends towards that of a neutrally buoyant release.

The ALOHA code uses a constant set of meteorological conditions (e.g., wind speed, stability class) to determine the downwind atmospheric concentrations. The sequential meteorological data sets used for the radiological accident analyses were re-ordered from high to low dispersion by applying a Gaussian dispersion model (such as that used by ALOHA) to the closest site boundary at each site. The median set of hourly conditions for each site (i.e., mean wind speed and mean stability) was used for the analysis; this is roughly equivalent to the conditions corresponding to the mean radiological dose estimates of MACCS2.

ALOHA contains physical and toxicological properties for the chemical spills included in the EIS and for approximately 1,000 additional chemicals. The physical properties were used to determine which of the dispersion models and accompanying parameters were applied. The toxicological properties were used to determine the levels of concern. Atmospheric concentrations at which health effects are of concern (e.g., ERPG-2) are used to define the footprint of concern because the meteorological conditions specified do not account for wind direction (i.e., it is not known *a priori* in which direction the wind would be blowing in the event of an accident) the areas of concern are defined by a circle of radius equivalent to the downwind distance at which the concentration decreases to levels less than the level of concern. The fraction of the area of concern actually exposed to the concentration of concern (footprint area/circle area) was noted. In addition, the concentration at 1,000 m (3,281 ft) (potential exposure to a non-involved worker) and at the nearest site boundary distance (exposure to maximum exposed offsite individual) are calculated and presented.

C.7 ACCIDENT ANALYSES CONSEQUENCES AND RISK RESULTS

The following sections describe the radiological and chemical impacts of potential accidents associated with MPF alternatives at LANL, NTS, Pantex, SRS, and WIPP and with the TA-55 Upgrade Alternative at LANL. Impacts for the MPF alternatives are provided for 125 ppy, 250 ppy, and 450 ppy production cases. Impacts for the TA-55 Upgrade Alternative are provided for an 80 ppy production case.

The impacts to humans that could result from potential radiological accident scenarios were evaluated in terms of dose units (such as rem or person-rem) and excess LCFs. The dose-to-risk conversion factors used were 0.0005 LCFs per rem (or person-rem) and 0.0004 LCFs per rem, respectively, for the public and workers. The lower value for workers reflects the absence of children (who are more radiosensitive than adults) in the workforce. For individuals, such as a worker or the maximum exposed offsite individual, the dose-to-rem conversion factors were doubled to 0.0008 and 0.001, respectively, when the dose exceeded 20 rem.

C.7.1 Modern Pit Facility Radiological Accident Frequency and Consequences

This section describes the impacts for each of the five MPF site alternatives. Impacts are shown in terms of dose and LCFs for the maximally exposed offsite individual, offsite population, and non-involved worker. The risks of LCFs are also shown for the maximally exposed offsite individual, offsite population, and non-involved worker.

C.7.1.1 Los Alamos Site Alternative

Table C.7.1.1–1. MPF Alternative Radiological Accident Frequency and Consequences at LANL for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	41.4	0.041	36,300	18.2	244	0.2
1.0×10^{-5}						
Fire in a Single Building	32.7	0.033	21,400	10.7	301	0.24
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	38.3	0.038	25,100	12.5	353	0.28
1.0×10^{-2}						
Nuclear Criticality	0.00012	5.8×10^{-8}	0.11	5.3×10^{-5}	0.0012	4.7×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.4	0.0012	1,670	0.84	23.5	0.019
1.0×10^{-2}						
Radioactive Material Spill	0.77	0.00036	502	0.25	7.1	0.0028
1.0×10^{-2}						

CRT = Cargo Restraint Transporter.
[a] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.1–2. Annual Cancer Risks for the MPF Alternative at LANL for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	4.1×10^{-7}	0.00018	2.0×10^{-6}
Fire in a Single Building	3.3×10^{-6}	0.0011	2.4×10^{-5}
Explosion in a Feed Casting Furnace	0.00038	0.125	0.0028
Nuclear Criticality	5.8×10^{-10}	5.3×10^{-7}	4.7×10^{-9}
Fire-induced Release in the CRT Storage Room	1.2×10^{-5}	0.0084	0.00019
Radioactive Material Spill	3.6×10^{-6}	0.0025	2.8×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

Table C.7.1.1–3. MPF Alternative Radiological Accident Frequency and Consequences at LANL for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	42.6	0.043	37,400	18.7	251	0.2
1.0×10^{-5}						
Fire in a Single Building	33.9	0.034	22,200	11.1	312	0.25
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	38.3	0.038	25,100	12.5	353	0.28
1.0×10^{-2}						
Nuclear Criticality	0.00012	5.8×10^{-8}	0.11	5.3×10^{-5}	0.0012	4.7×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.4	0.0012	1,670	0.84	23.5	0.019
1.0×10^{-2}						
Radioactive Material Spill	0.77	0.00036	502	0.25	7.1	0.0028
1.0×10^{-2}						

[a] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.1–4. Annual Cancer Risks for the MPF Alternative at LANL for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	4.3×10^{-7}	0.00019	2.0×10^{-6}
Fire in a Single Building	3.4×10^{-6}	0.0011	2.5×10^{-5}
Explosion in a Feed Casting Furnace	0.00038	0.125	0.0028
Nuclear Criticality	5.8×10^{-10}	5.3×10^{-7}	4.7×10^{-9}
Fire-induced Release in the CRT Storage Room	1.2×10^{-5}	0.0084	0.00019
Radioactive Material Spill	3.6×10^{-6}	0.0025	2.8×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

Table C.7.1.1–5. MPF Alternative Radiological Accident Frequency and Consequences at LANL for 450 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	82.1	0.082	72,000	36	484	0.39
1.0×10^{-5}						
Fire in a Single Building	65.7	0.066	43,000	21.5	605	0.48
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	38.3	0.038	25,100	12.5	353	0.28
1.0×10^{-2}						
Nuclear Criticality	0.00012	5.8×10^{-8}	0.11	5.3×10^{-5}	0.0012	4.7×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	5.1	0.0024	3,340	1.67	47	0.038
1.0×10^{-2}						
Radioactive Material Spill	0.77	0.00036	502	0.25	7.05	0.0028
1.0×10^{-2}						

[a] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.1–6. Annual Cancer Risks for the MPF Alternative at LANL for 450 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	8.2×10^{-7}	0.00036	3.9×10^{-6}
Fire in a Single Building	6.6×10^{-6}	0.0022	4.8×10^{-5}
Explosion in a Feed Casting Furnace	0.00038	0.125	0.0028
Nuclear Criticality	5.8×10^{10}	5.3×10^{-7}	4.7×10^{-9}
Fire-induced Release in the CRT Storage Room	2.4×10^{-5}	0.017	0.00038
Radioactive Material Spill	3.6×10^{-6}	0.0025	2.8×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

C.7.1.2 Nevada Test Site Alternative

Table C.7.1.2–1. MPF Alternative Radiological Accident Frequency and Consequences at NTS for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	2.71	0.0014	1,120	0.56	239	0.19
1.0×10^{-5}						
Fire in a Single Building	1.27	0.00064	504	0.25	124	0.099
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.49	0.00074	591	0.3	145	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.0012	5.8×10^{-7}	0.00049	2.5×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.099	5.0×10^{-5}	39.4	0.02	9.69	0.0048
1.0×10^{-2}						
Radioactive Material Spill	0.03	1.5×10^{-5}	11.8	0.0059	2.91	0.0015
1.0×10^{-2}						

[a] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.2–2. Annual Cancer Risks for the MPF Alternative at NTS for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.4×10^{-8}	5.6×10^{-6}	1.9×10^{-6}
Fire in a Single Building	6.4×10^{-8}	2.5×10^{-5}	9.9×10^{-6}
Explosion in a Feed Casting Furnace	7.4×10^{-6}	0.003	0.0012
Nuclear Criticality	1.7×10^{-11}	5.8×10^{-9}	2.5×10^{-9}
Fire-induced Release in the CRT Storage Room	5.0×10^{-7}	0.0002	4.8×10^{-5}
Radioactive Material Spill	1.5×10^{-7}	5.9×10^{-5}	1.5×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.

Table C.7.1.2–3. MPF Alternative Radiological Accident Frequency and Consequences at NTS for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	2.8	0.0014	1,150	0.58	246	0.2
1.0×10^{-5}						
Fire in a Single Building	1.32	0.00066	522	0.26	129	0.1
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.49	0.00074	591	0.3	145	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.0012	5.8×10^{-7}	0.00049	2.5×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.099	5.0×10^{-5}	39.4	0.02	9.69	0.0048
1.0×10^{-2}						
Radioactive Material Spill	0.03	1.5×10^{-5}	11.8	0.0059	2.91	0.0015
1.0×10^{-2}						

[a] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.2–4. Annual Cancer Risks for the MPF Alternative at NTS for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.4×10^{-8}	5.8×10^{-6}	2.0×10^{-6}
Fire in a Single Building	6.6×10^{-8}	2.6×10^{-5}	1.0×10^{-5}
Explosion in a Feed Casting Furnace	7.4×10^{-6}	0.003	0.0012
Nuclear Criticality	1.7×10^{-11}	5.8×10^{-9}	2.5×10^{-9}
Fire-induced Release in the CRT Storage Room	5.0×10^{-7}	0.0002	4.8×10^{-5}
Radioactive Material Spill	1.5×10^{-7}	5.9×10^{-5}	1.5×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.

Table C.7.1.2–5. MPF Alternative Radiological Accident Frequency and Consequences at NTS for 450 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	5.38	0.0027	2,220	1.11	474	0.38
1.0×10^{-5}						
Fire in a Single Building	2.55	0.0013	1,010	0.51	249	0.2
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.49	0.00074	591	0.3	145	0.12
1.0×10^{-2}						
Nuclear Criticality	3.5×10^{-6}	1.7×10^{-9}	0.0012	5.8×10^{-7}	0.00049	2.5×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.20	9.9×10^{-5}	78.8	0.039	19.4	0.0097
1.0×10^{-2}						
Radioactive Material Spill	0.030	1.5×10^{-5}	11.8	0.0059	2.91	0.0015
1.0×10^{-2}						

[a] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.2–6. Annual Cancer Risks for the MPF Alternative at NTS for 450 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	2.7×10^{-8}	1.1×10^{-5}	3.8×10^{-6}
Fire in a Single Building	1.3×10^{-7}	5.1×10^{-5}	2.0×10^{-5}
Explosion in a Feed Casting Furnace	7.4×10^{-6}	0.003	0.0012
Nuclear Criticality	1.7×10^{-11}	5.8×10^{-9}	2.5×10^{-9}
Fire-induced Release in the CRT Storage Room	9.9×10^{-7}	0.00039	9.7×10^{-5}
Radioactive Material Spill	1.5×10^{-7}	5.9×10^{-5}	1.5×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 69,501 persons residing within 80 km (50 mi) of NTS.

C.7.1.3 Pantex Site Alternative

Table C.7.1.3–1. MPF Alternative Radiological Accident Frequency and Consequences at Pantex for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	29.1	0.029	8,320	4.16	232	0.19
1.0×10^{-5}						
Fire in a Single Building	15	0.0075	3,920	1.96	140	0.11
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	17.6	0.0088	4,590	2.3	164	0.13
1.0×10^{-2}						
Nuclear Criticality	6.4×10^{-5}	3.2×10^{-8}	0.012	6.0×10^{-6}	0.0006	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	1.2	0.00059	306	0.15	10.9	0.0044
1.0×10^{-2}						
Radioactive Material Spill	0.35	0.00018	91.9	0.046	3.28	0.0013
1.0×10^{-2}						

[a] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.3–2. Annual Cancer Risks for the MPF Alternative at Pantex for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	2.9×10^{-7}	4.2×10^{-5}	1.9×10^{-6}
Fire in a Single Building	7.5×10^{-7}	0.0002	1.1×10^{-5}
Explosion in a Feed Casting Furnace	8.8×10^{-5}	0.023	0.0013
Nuclear Criticality	3.2×10^{-10}	6.0×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	5.9×10^{-6}	0.0015	4.4×10^{-5}
Radioactive Material Spill	1.8×10^{-6}	0.00046	1.3×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.

Table C.7.1.3–3. MPF Alternative Radiological Accident Frequency and Consequences at Pantex for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	30	0.03	8,570	4.29	239	0.19
1.0×10^{-5}						
Fire in a Single Building	15.5	0.0078	4,060	2.0	145	0.12
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	17.6	0.0088	4,590	2.3	164	0.13
1.0×10^{-2}						
Nuclear Criticality	6.4×10^{-5}	3.2×10^{-8}	0.012	6.0×10^{-6}	0.0006	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	1.2	0.00059	306	0.15	10.9	0.0044
1.0×10^{-2}						
Radioactive Material Spill	0.35	0.00018	91.9	0.046	3.28	0.0013
1.0×10^{-2}						

[a] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.3–4. Annual Cancer Risks for the MPF Alternative at Pantex for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	3.0×10^{-7}	4.3×10^{-5}	1.9×10^{-6}
Fire in a Single Building	7.8×10^{-7}	0.0002	1.2×10^{-5}
Explosion in a Feed Casting Furnace	8.8×10^{-5}	0.023	0.0013
Nuclear Criticality	3.2×10^{-10}	6.0×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	5.9×10^{-6}	0.0015	4.4×10^{-5}
Radioactive Material Spill	1.8×10^{-6}	0.00046	1.3×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.

Table C.7.1.3–5. MPF Alternative Radiological Accident Frequency and Consequences at Pantex for 450 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	57.7	0.058	16,500	8.25	460	0.37
1.0×10^{-5}						
Fire in a Single Building	30.2	0.03	7,880	3.94	281	0.23
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	17.6	0.0088	4,590	2.0	164	0.13
1.0×10^{-2}						
Nuclear Criticality	6.3×10^{-5}	3.2×10^{-8}	0.012	6.0×10^{-6}	0.0006	2.4×10^{-6}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.34	0.0012	6.3	0.31	21.9	0.018
1.0×10^{-2}						
Radioactive Material Spill	0.35	0.00018	91.9	0.046	3.28	0.0013
1.0×10^{-2}						

[a] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.3–6. Annual Cancer Risks for the MPF Alternative at Pantex for 450 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	5.8×10^{-7}	8.3×10^{-5}	3.7×10^{-6}
Fire in a Single Building	3.0×10^{-6}	0.0004	2.3×10^{-5}
Explosion in a Feed Casting Furnace	8.8×10^{-5}	0.023	0.0013
Nuclear Criticality	3.2×10^{-10}	6.0×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	1.2×10^{-5}	0.0031	0.00018
Radioactive Material Spill	1.8×10^{-6}	0.00046	1.3×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 422,287 persons residing within 80 km (50 mi) of Pantex.

C.7.1.4 Savannah River Site Alternative

Table C.7.1.4–1. MPF Alternative Radiological Accident Frequency and Consequences at SRS for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	3.16	0.0016	13,100	6.55	207	0.17
1.0×10^{-5}						
Fire in a Single Building	1.64	0.00082	5,930	3.0	127	0.1
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.92	0.00096	6,950	3.5	149	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.013	6.3×10^{-6}	0.00061	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.13	6.4×10^{-5}	463	0.23	9.92	0.004
1.0×10^{-2}						
Radioactive Material Spill	0.038	1.9×10^{-5}	139	0.07	2.98	0.0012
1.0×10^{-2}						

[a] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.4–2. Annual Cancer Risks for the MPF Alternative at SRS for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.6×10^{-8}	6.6×10^{-5}	1.7×10^{-6}
Fire in a Single Building	8.2×10^{-8}	0.0003	1.0×10^{-5}
Explosion in a Feed Casting Furnace	9.6×10^{-6}	0.035	0.0012
Nuclear Criticality	1.7×10^{-11}	6.3×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	6.4×10^{-7}	0.0023	4.0×10^{-5}
Radioactive Material Spill	1.9×10^{-7}	0.0007	1.2×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.

Table C.7.1.4–3. MPF Alternative Radiological Accident Frequency and Consequences at SRS for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	3.26	0.0016	13,500	6.75	213	0.17
1.0×10^{-5}						
Fire in a Single Building	1.7	0.00085	6,150	3.07	132	0.11
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.92	0.00096	6,950	3.47	149	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.013	6.3×10^{-6}	0.00061	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.13	6.4×10^{-5}	463	0.23	9.92	0.004
1.0×10^{-2}						
Radioactive Material Spill	0.038	1.9×10^{-5}	139	0.07	3.0	0.0012
1.0×10^{-2}						

[a] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.4–4. Annual Cancer Risks for the MPF Alternative at SRS for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.6×10^{-8}	6.8×10^{-5}	1.7×10^{-6}
Fire in a Single Building	8.5×10^{-8}	0.00031	1.1×10^{-5}
Explosion in a Feed Casting Furnace	9.6×10^{-6}	0.035	0.0012
Nuclear Criticality	1.7×10^{-11}	6.3×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	6.4×10^{-7}	0.0023	4.0×10^{-5}
Radioactive Material Spill	1.9×10^{-7}	0.0007	1.2×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.

Table C.7.1.4–5. MPF Alternative Radiological Accident Frequency and Consequences at SRS for 450 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	6.27	0.0031	26,000	13	411	0.33
1.0×10^{-5}						
Fire in a Single Building	3.3	0.0017	11,900	5.96	255	0.2
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	1.92	0.00096	6,950	3.47	149	0.12
1.0×10^{-2}						
Nuclear Criticality	3.4×10^{-6}	1.7×10^{-9}	0.013	6.3×10^{-6}	0.00061	2.4×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	0.26	1.3×10^{-4}	927	0.46	19.8	0.0079
1.0×10^{-2}						
Radioactive Material Spill	0.038	1.9×10^{-5}	139	0.07	2.98	0.0012
1.0×10^{-2}						

[a] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.4–6. Annual Cancer Risks for the MPF Alternative at SRS for 450 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	3.1×10^{-8}	0.00013	3.3×10^{-6}
Fire in a Single Building	1.7×10^{-7}	0.0006	2.0×10^{-5}
Explosion in a Feed Casting Furnace	9.6×10^{-6}	0.035	0.0012
Nuclear Criticality	1.7×10^{-11}	6.3×10^{-8}	2.4×10^{-9}
Fire-induced Release in the CRT Storage Room	1.3×10^{-6}	0.0046	7.9×10^{-5}
Radioactive Material Spill	1.9×10^{-7}	0.0007	1.2×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 1,085,852 persons residing within 80 km (50 mi) of SRS.

C.7.1.5 Carlsbad Site Alternative

Table C.7.1.5–1. MPF Alternative Radiological Accident Frequency and Consequences at the Carlsbad Site for 125 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	50.3	0.05	3,000	1.5	331	0.27
1.0×10^{-5}						
Fire in a Single Building	26.5	0.027	1,380	0.69	206	0.17
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	31.1	0.031	1,620	0.81	241	0.19
1.0×10^{-2}						
Nuclear Criticality	9.9×10^{-5}	5.0×10^{-8}	0.0046	2.3×10^{-6}	0.00076	3.0×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.1	0.001	108	0.054	16.1	0.0064
1.0×10^{-2}						
Radioactive Material Spill	0.62	0.00031	32.3	0.016	4.83	0.0019
1.0×10^{-2}						

[a] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.5–2. Annual Cancer Risks for the MPF Alternative at the Carlsbad Site for 125 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	5.0×10^{-7}	1.5×10^{-5}	2.7×10^{-6}
Fire in a Single Building	2.7×10^{-6}	6.9×10^{-5}	1.7×10^{-5}
Explosion in a Feed Casting Furnace	0.00031	0.0081	0.0019
Nuclear Criticality	5.0×10^{-10}	2.3×10^{-8}	3.0×10^{-9}
Fire-induced Release in the CRT Storage Room	1.0×10^{-5}	0.00054	6.4×10^{-5}
Radioactive Material Spill	3.1×10^{-6}	0.00016	1.9×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.

Table C.7.1.5–3. MPF Alternative Radiological Accident Frequency and Consequences at the Carlsbad Site for 250 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	51.8	0.052	3,090	1.55	341	0.27
1.0×10^{-5}						
Fire in a Single Building	27.5	0.028	1,430	0.72	214	0.17
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	31.1	0.031	1,620	0.81	241	0.19
1.0×10^{-2}						
Nuclear Criticality	9.9×10^{-5}	5.0×10^{-8}	0.0046	2.3×10^{-6}	0.0076	3.0×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	2.1	0.001	108	0.054	16.1	0.0064
1.0×10^{-2}						
Radioactive Material Spill	0.62	0.00031	32.3	0.016	4.83	0.0019
1.0×10^{-2}						

[a] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.5–4. Annual Cancer Risks for the MPF Alternative at the Carlsbad Site for 250 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	5.2×10^{-7}	1.6×10^{-5}	2.7×10^{-6}
Fire in a Single Building	2.8×10^{-6}	7.2×10^{-5}	1.7×10^{-5}
Explosion in a Feed Casting Furnace	0.00031	0.0081	0.0019
Nuclear Criticality	5.0×10^{-10}	2.3×10^{-8}	3.0×10^{-9}
Fire-induced Release in the CRT Storage Room	1.0×10^{-5}	0.00054	6.4×10^{-5}
Radioactive Material Spill	3.1×10^{-6}	0.00016	1.9×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.

Table C.7.1.5–5. MPF Alternative Radiological Accident Frequency and Consequences at the Carlsbad Site for 450 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	99.8	0.1	5,950	2.98	657	0.53
1.0×10^{-5}						
Fire in a Single Building	53.3	0.053	2,770	1.39	414	0.33
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	31.1	0.031	1,620	0.81	241	0.19
1.0×10^{-2}						
Nuclear Criticality	9.9×10^{-5}	5.0×10^{-8}	0.0046	2.3×10^{-6}	0.00076	3.0×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	4.14	0.0021	216	0.11	322	0.026
1.0×10^{-2}						
Radioactive Material Spill	0.62	0.00031	32.3	0.016	4.83	0.0019
1.0×10^{-2}						

[a] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.1.5–6. Annual Cancer Risks for the MPF Alternative at the Carlsbad Site for 450 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	1.0×10^{-6}	3.0×10^{-5}	5.3×10^{-6}
Fire in a Single Building	5.3×10^{-6}	0.00014	3.3×10^{-5}
Explosion in a Feed Casting Furnace	0.00031	0.0081	0.0019
Nuclear Criticality	5.0×10^{-10}	2.3×10^{-8}	3.0×10^{-9}
Fire-induced Release in the CRT Storage Room	2.1×10^{-5}	0.0011	0.00026
Radioactive Material Spill	3.1×10^{-6}	0.00016	1.9×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs.
[c] Based on a year-2043 population of 117,796 persons residing within 80 km (50 mi) of WIPP.

C.7.2 Modern Pit Facility Chemical Accident Frequency and Consequences

The chemicals selected for evaluation are based on the aqueous feed preparation process, as noted in each table, and are considered the most hazardous of all the chemicals used in this process. Determination of a chemical's hazardous ranking takes into account quantities available for release, protective concentration limits (ERPG-2) and evaporation rate. The most hazardous chemical used in an alternative method, the pyrochemical processing method is also analyzed as noted in the tables.

This section describes the impacts of potential chemical accidents at each of the five MPF alternatives and for the 125 ppy, 250 ppy, and 450 ppy production cases. The tables show the name of the chemical and the quantity released during a severe accident. The impacts of chemical releases are measured in terms of ERPG-2 protective concentration limits given in ppm. The distances at which the limit is reached are also provided for the ERPG-2 limit. The concentration of the chemical at 1,000 m (3,281 ft) from the accident is shown for comparison with the concentration limit for ERPG-2. The distance to the site boundary and the concentration at the site boundary are also shown for comparison with the ERPG-2 concentration limits and for determining if the limits are exceeded offsite.

C.7.2.1 Los Alamos Site Alternative

This section describes the impacts associated with the MPF LANL Alternative.

Table C.7.2.1–1. MPF Alternative Chemical Accident Frequency and Consequences at LANL for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 1.75 km (ppm)	
Nitric acid[b]	10,500	6	0.68	3.16	1.28	10^{-4}
Hydrofluoric acid[b]	550	20	0.61	6.98	2.43	10^{-4}
Formic acid[b]	1,500	10	0.19	0.51	0.202	10^{-4}
Hydrochloric Acid[c]	600	20	2	69.2	24.8	10^{-4}

[a] Site boundary is at a distance of 1.75 km (1.1 mi) north.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.1–2. MPF Alternative Chemical Accident Frequency and Consequences at LANL for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	Site Boundary at 1.75 km (ppm)	
Nitric acid[b]	21,000	6	1.4	11.4	3.31	10^{-4}
Hydrofluoric acid[b]	1,100	20	0.83	13.4	4.02	10^{-4}
Formic acid[b]	3,000	10	0.26	0.975	0.34	10^{-4}
Hydrochloric acid[c]	1,200	20	2.7	124	46.4	10^{-4}

[a] Site boundary is at a distance of 1.75 km (1.1 mi) north.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.1–3. MPF Alternative Chemical Accident Frequency and Consequences at LANL for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 1.75 km (ppm)	
Nitric acid[b]	40,000	6	1.9	20.3	7.29	10^{-4}
Hydrofluoric acid[b]	2,000	20	1.1	23.7	8.42	10^{-4}
Formic acid[b]	5,500	10	0.36	1.73	0.694	10^{-4}
Hydrochloric acid[c]	2,200	20	3.5	188	77.7	10^{-4}

[a] Site boundary is at a distance of 1.75 km (1.1 mi) north.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.2.2 Nevada Test Site Alternative

This section describes the impacts associated with the MPF NTS Alternative.

Table C.7.2.2–1. MPF Alternative Chemical Accident Frequency and Consequences at NTS for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 7.6 km (ppm)	
Nitric acid[b]	10,500	6	0.28	0.5	0.01	10^{-4}
Hydrofluoric acid[b]	550	20	0.35	2.0	0.016	10^{-4}
Formic acid[b]	1,500	10	0.08	0.07	0	10^{-4}
Hydrochloric acid[c]	600	20	1.1	26.3	0.35	10^{-4}

[a] Site boundary is at a distance of 7.6 km (4.7 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.2–2. MPF Alternative Chemical Accident Frequency and Consequences at NTS for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 7.6 km (ppm)	
Nitric acid[b]	21,000	6	0.4	0.98	0.02	10^{-4}
Hydrofluoric acid[b]	1,100	20	0.48	3.9	0.03	10^{-4}
Formic acid[b]	3,000	10	0.12	0.14	0	10^{-4}
Hydrochloric acid[c]	1,200	20	1.6	50.9	0.68	10^{-4}

[a] Site boundary is at a distance of 7.6 km (4.7 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.2–3. MPF Alternative Chemical Accident Frequency and Consequences at NTS for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 7.6 km (ppm)	
Nitric acid[b]	40,000	6	0.54	1.8	0.038	10^{-4}
Hydrofluoric acid[b]	2,000	20	0.64	6.93	0.056	10^{-4}
Formic acid[b]	5,500	10	0.15	0.25	0.0054	10^{-4}
Hydrochloric acid[c]	2,200	20	2.1	90.7	1.22	10^{-4}

[a] Site boundary is at a distance of 7.6 km (4.7 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.2.3 Pantex Site Alternative

This section describes the impacts associated with the MPF Pantex Alternative.

Table C.7.2.3–1. MPF Alternative Chemical Accident Frequency and Consequences at Pantex for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.5 km (ppm)	
Nitric acid[b]	10,500	6	0.59	2.49	0.58	10^{-4}
Hydrofluoric acid[b]	550	20	0.59	5.25	0.99	10^{-4}
Formic acid[b]	1,500	10	0.16	0.37	0.87	10^{-4}
Hydrochloric acid[c]	600	20	1.8	60.8	10.4	10^{-4}

[a] Site boundary is at a distance of 2.5 km (1.5 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.3–2. MPF Alternative Chemical Accident Frequency and Consequences at Pantex for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.5 km (ppm)	
Nitric acid[b]	21,000	6	0.88	4.82	1.14	10^{-4}
Hydrofluoric acid[b]	1,100	20	0.83	10.2	1.94	10^{-4}
Formic acid[b]	3,000	10	0.22	0.72	0.17	10^{-4}
Hydrochloric acid[c]	1,200	20	2.5	117	20	10^{-4}

[a] Site boundary is at a distance of 2.5 km (1.5 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.3–3. MPF Alternative Chemical Accident Frequency and Consequences at Pantex for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.5 km (ppm)	
Nitric acid[b]	40,000	6	1.3	8.89	2.11	10^{-4}
Hydrofluoric acid[b]	2,000	20	1.1	18.2	3.46	10^{-4}
Formic acid[b]	5,500	10	0.3	1.28	0.3	10^{-4}
Hydrochloric acid[c]	2,200	20	3.3	202	35.1	10^{-4}

[a] Site boundary is at a distance of 2.5 km (1.5 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.2.4 Savannah River Site Alternative

This section describes the impacts associated with the MPF SRS Alternative.

Table C.7.2.4–1. MPF Alternative Chemical Accident Frequency and Consequences at SRS for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 8.7 km (ppm)	
Nitric acid[b]	10,500	6	0.44	1.27	0.017	10^{-4}
Hydrofluoric acid[b]	550	20	0.49	3.35	0.03	10^{-4}
Formic acid[b]	1,500	10	0.13	0.19	0	10^{-4}
Hydrochloric acid[c]	600	20	1.5	42.2	0.361	10^{-4}

[a] Site boundary is at a distance of 8.7 km (4.5 mi) west.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.4–2. MPF Alternative Chemical Accident Frequency and Consequences at SRS for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 8.7 km (ppm)	
Nitric acid[b]	21,000	6	0.62	2.45	0.032	10^{-4}
Hydrofluoric acid[b]	1,100	20	0.66	6.51	0.06	10^{-4}
Formic acid[b]	3,000	10	0.18	0.37	0	10^{-4}
Hydrochloric acid[c]	1,200	20	2.1	81	0.71	10^{-4}

[a] Site boundary is at a distance of 8.7 km (4.5 mi) west.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.4–3. MPF Alternative Chemical Accident Frequency and Consequences at SRS for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 8.7 km (ppm)	
Nitric acid[b]	40,000	6	0.86	4.52	0.06	10^{-4}
Hydrofluoric acid[b]	2,000	20	0.83	11.5	0.11	10^{-4}
Formic acid[b]	5,500	10	0.24	0.66	0.0084	10^{-4}
Hydrochloric acid[c]	2,200	20	2.8	144	1.28	10^{-4}

[a] Site boundary is at a distance of 8.7 km (4.5 mi) west.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.2.5 Carlsbad Site Alternative

This section describes the impacts associated with the MPF Carlsbad Site Alternative.

Table C.7.2.5–1. MPF Alternative Chemical Accident Frequency and Consequences at the Carlsbad Site for 125 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.3 km (ppm)	
Nitric acid[b]	10,500	6	1.0	6.18	1.57	10^{-4}
Hydrofluoric acid[b]	550	20	0.81	12.7	2.49	10^{-4}
Formic acid[b]	1,500	10	0.28	0.97	0.24	10^{-4}
Hydrochloric acid[c]	600	20	2.4	97.6	20.6	10^{-4}

[a] Site boundary is at a distance of 2.3 km (1.4 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.5–2. MPF Alternative Chemical Accident Frequency and Consequences at the Carlsbad Site for 250 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.3 km (ppm)	
Nitric acid[b]	21,000	6	1.5	11.9	3.04	10^{-4}
Hydrofluoric acid[b]	1,100	20	1.1	24.6	4.86	10^{-4}
Formic acid[b]	3,000	10	0.39	1.88	0.47	10^{-4}
Hydrochloric acid[c]	1,200	20	3.3	174	38.7	10^{-4}

[a] Site boundary is at a distance of 2.3 km (1.4 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

Table C.7.2.5–3. MPF Alternative Chemical Accident Frequency and Consequences at the Carlsbad Site for 450 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 2.3 km (ppm)	
Nitric acid[b]	40,000	6	2.3	21.9	5.64	10^{-4}
Hydrofluoric acid[b]	2,000	20	1.5	43.7	8.71	10^{-4}
Formic acid[b]	5,500	10	0.54	3.36	0.85	10^{-4}
Hydrochloric acid[c]	2,200	20	4.3	262	66.2	10^{-4}

[a] Site boundary is at a distance of 2.3 km (1.4 mi) east.
[b] Chemicals used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.3 Radiological Accident Frequency and Consequences for the TA-55 Upgrade Alternative

This section describes the radiological accident impacts associated with the TA-55 Upgrade Alternative at LANL.

Table C.7.3–1. Upgrade Alternative Radiological Accident Frequency and Consequences at LANL for 80 ppy

Frequency (per year)	Maximally Exposed Offsite Individual		Offsite Population[a]		Non-involved Worker	
	Dose (rem)	LCFs[b]	Dose (person-rem)	LCFs[c]	Dose (rem)	LCFs[b]
Beyond Evaluation Basis Earthquake with Fire	26.4	0.026	23,200	11.6	156	0.13
1.0×10^{-5}						
Fire in a Single Building	20.9	0.021	13,700	6.85	193	0.15
1.0×10^{-4}						
Explosion in a Feed Casting Furnace	38.3	0.038	25,100	12.5	353	0.28
1.0×10^{-2}						
Nuclear Criticality	0.00012	5.8×10^{-8}	0.11	5.3×10^{-5}	0.0012	4.7×10^{-7}
1.0×10^{-2}						
Fire-induced Release in the CRT Storage Room	1.6	0.0008	1,070	0.54	151	0.006
1.0×10^{-2}						
Radioactive Material Spill	0.77	0.00036	502	0.25	7.05	0.0028
1×10^{-2}						

[a] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.
[b] Increased likelihood of a LCF.
[c] Increased likelihood of LCFs.

Table C.7.3–2. Annual Cancer Risks for the Upgrade Alternative at LANL for 80 ppy

Accident	Maximally Exposed Offsite Individual[a]	Offsite Population[b,c]	Non-involved Worker[a]
Beyond Evaluation Basis Earthquake with Fire	2.6×10^{-7}	0.00012	1.3×10^{-6}
Fire in a Single Building	2.1×10^{-7}	0.00069	1.5×10^{-5}
Explosion in a Feed Casting Furnace	0.00038	0.13	0.0028
Nuclear Criticality	5.6×10^{-10}	5.3×10^{-7}	4.7×10^{-9}
Fire-induced Release in the CRT Storage Room	8.0×10^{-6}	0.0054	6.0×10^{-5}
Radioactive Material Spill	3.6×10^{-6}	0.0025	2.8×10^{-5}

[a] Increased likelihood of a LCF.
[b] Increased likelihood of LCFs
[c] Based on a year-2043 population of 586,335 persons residing within 80 km (50 mi) of LANL.

C.7.4 Chemical Accident Frequency and Consequences for the TA-55 Upgrade Alternative

This section describes the chemical accident impacts for the TA-55 Upgrade Alternative at LANL for the single production case of 80 ppy.

Table C.7.4–1. Upgrade Alternative Chemical Accident Frequency and Consequences for 80 ppy

Chemical Released	Quantity Released (kg)	ERPG-2 [a]		Concentration [a]		Frequency
		Limit (ppm)	Distance to Limit (km)	At 1,000 m (ppm)	At Site Boundary 1.75 km (ppm)	
Nitric acid[b]	3,420	6	0.37	1.08	0.44	10^{-4}
Hydrofluoric acid[b]	340	20	0.5	4.44	1.54	10^{-4}
Hydrochloric acid[c]	384	20	1.6	47.1	16.6	10^{-4}

[a] Site boundary is at a distance of 1.75 km (1.1 mi) north.
[b] Chemical used in the aqueous processing method.
[c] Chemical used in the pyrochemical processing method.

C.7.5 Chemical Dispersion Plumes

The chemical accident scenario postulates a release of the chemical and the formation of a chemical pool of one-inch depth in the area surrounding the release. The release could be a result of a pipe or tank rupture. Based on the chemical's properties, evaporation will take place producing an airborne plume that travels in the direction of the wind at the time of the accident. This section provides a graphic representation of the plume with respect to on site and offsite locations.

The plumes for two chemicals have been evaluated, nitric acid for the aqueous plutonium process and hydrochloric acid for the pyrochemical plutonium process. These two chemicals are considered the most hazardous for the indicated process. They are also based on the maximum pit production case of 450 pits per year.

The plume (Figures C.7.5-1 through C.7.5-10) is shown as emanating from the point of release in a direction towards where the maximum exposed individual for radiological accidents would be located. The farthest end of the plume is the point where the ERPG-2 concentration level is no longer exceeded. Concentrations closer to the point of release will be higher then ERPG-2 and at some point exceed the higher concentration limit defined by ERPG-3.

Although the direction of the plume is graphically positioned towards the site boundary where the maximum exposed individual for radiological accidents would be located, in reality the plume will travel in a direction determined by the wind direction at the time of the accident. Thus, the plume could be positioned in a direction anywhere in the circle surrounding the point of release. In the event of an accident, all individuals in the plume as determined by the wind direction at the time will be exposed to harmful chemical concentrations in excess of ERPG-2 and in some cases, in excess of ERPG-3.

Plumes for the TA-55 upgrade case are not shown because the plume concentrations are smaller than the TA-55 MPF Alternative at LANL.

C.8 ANALYSIS CONSERVATISM AND UNCERTAINTY

The analysis of accidents is based on calculations relevant to hypothetical sequences of events and models of their potential impacts. The models provide estimates of the frequencies, source terms, pathways for dispersion, exposures, and the effects on human health and the environment as realistic as possible within the scope of the analysis. In many cases, the scarcity of experience with the postulated accidents leads to uncertainty in the calculation of the consequences and frequencies. This fact has promoted the use of models or input values that yield conservative estimates of consequences and frequency. Additionally, since no credit is taken for safety systems that may function during this event, these events do not represent expected conditions within the facility at any point in its lifetime.

Due to the layers of conservatism built into the accident analysis for the spectrum of postulated accidents, the estimated consequences and risks to the public represent the upper limit for the individual classes of accidents. The uncertainties associated with the accident frequency estimates are enveloped by the analysis conservatism.

Of particular interest are the uncertainties in the estimates of cancer fatalities from exposure to radioactive materials. The numerical values of the health risk estimators used in this EIS were obtained by linear extrapolation from the nominal risk estimate for lifetime total cancer mortality resulting from exposures of 10 rad, because the health risk estimators are multiplied by conservatively calculated radiological doses to predict fatal cancer risks. The fatal cancer values presented in this EIS are expected to be overestimates.

For the purposes of this EIS, the impacts calculated from the linear model are treated as an upper-bound case, consistent with the widely used methodologies for quantifying radiogenic health impacts. This does not imply that health effects are expected. Moreover, in cases where the upper-bound estimators predict a number of LCFs greater than 1, this does not imply that the LCF risk can be determined for a specific individual.